Proactive by Design

MAGNOLIA PIER
CONDITION ASSESSMENT REPORT
MAGNOLIA HARBOR
Gloucester, Massachusetts

June 2018
File No. 18.0173724.00

PREPARED FOR:
City of Gloucester
Gloucester, Massachusetts

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APPENDICES

A. GENERAL

1. INTRODUCTION

GZA GeoEnvironmental, Inc. (GZA), is submitting the following Magnolia Pier Condition Assessment Report with attached photographs, reference site plan, typical pier sections, condition assessment notes, budgetary repair/replacement cost estimates, and existing DEP Chapter 91 license information in response to the damage that occurred to the timber pier from the March 2018 Nor'easter storm events.

On May 22, 2018, engineers from GZA performed a one-day above-water and underwater inspection of the City of Gloucester-owned Magnolia Pier; an existing timber pile-supported pier located in Magnolia Harbor, Gloucester, Massachusetts, in accordance with our agreement dated May 2, 2018.

The inspection was limited to the accessible above-water and underwater portions of the timber pier. The purpose of the inspection was to observe and document the existing conditions of the timber pier after the recent March 2018 Nor'easter storm events and to provide recommendations and budgetary cost estimates for repairs and/or replacement. Repair/Replacement alternates and associates costs are not based on final design, therefore are subject to change. No utilities/building structures, floats, gangways or any other ancillary structures associated with the pier were included in the inspection scope of work.

GZA performed a similar pile inspection and conditions assessment report in September 2015, to establish a baseline of existing conditions for use in future inspections. Information from the 2015 pile inspection report was used in development of this report and attachments.

The structures observed were assessed a condition rating based on the following Condition Rating Assessment table:

Table 1 - Condition Rating Assessment

Rating	Description
6 - Good	No visible damage, or only minor damage is noted. Structural elements may show very minor deterioration, but no overstressing is observed. No repairs are required.
5 - Satisfactory	Limit minor to moderate defects or deterioration are observed, but no overstressing is observed. No repairs are required.
4 - Fair	All primary structural elements are sound, but minor to moderate defects or deterioration is observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repair is low
3 - Poor	Advanced deterioration or overstressing is observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.

Table 1 - Condition Rating Assessment	
Rating	**Description**
2 - Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1 – Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high priority basis with strong urgency.

Table 2-4. From Routine Underwater Condition Assessment Ratings, Page 21, Underwater Investigations Standard Practice Manual, as published in the ASCE Manuals and Reports on Engineering Practice No.101, Copyright 2001.

2. INSPECTION PROCEDURES

Prior to conducting the field inspection work, GZA reviewed the prior pier inspection report from 2015 along with available post storm photographs. Review of available information provided the on-site inspection crew with the knowledge of the pier structure and conditions prior to site arrival.

The above-water and underwater inspections included visual and tactile inspections of the existing accessible timber piles and the remaining above-water pier elements including but not limited to; pile caps, stringers, bracing, decking, railing and fasteners as readily and safely accessible. The inspection procedures included documentation of existing conditions of the piles and pier structure by field notes, photography, and videography. Access to the structures during the inspection was from GZA's survey vessel and by engineer-divers accessing from the shoreline.

The underwater inspections were performed in accordance with OSHA Subpart T – Commercial Diving directives and the American Society of Civil Engineers (ASCE), Underwater Investigations, Standard Practice Manual, No. 101. Underwater dive operations were performed during the day in approximately 0 to 12-foot water depths with 50-degree water temperature and approximately 8 to 12-foot visibility. Inspection limitations are indicated in **Appendix A.**

The underwater inspections included a Level I inspection effort that involved visual and tactile inspections of the various pier components and a limited Level II inspection. Level I inspection is generally referred to as a "swim-by" inspection, performed to the level of detail necessary to detect obvious major damage or deterioration. For this inspection, 100 percent of the piles were included in the Level I inspection. In addition, GZA performed limited Level II inspection efforts to include removal of marine growth or scaling to expose an approximate 12-inch square area at selected areas of the timber piles. Level II inspection was performed on select piles as applicable. Level II inspections are directed towards detecting and identifying deteriorated areas that may be hidden by surface biofouling or deterioration.

Other tactile inspection methods included performing probes and hammer soundings on select piles. One timber core was collected from Pile B19B, consisting of a ¼-inch diameter core approximately 7 inches in length. This sample was collected to assess the penetration depth of the protective creosote treatment. Upon extraction of the core sample, a timber dowel was driven into the core hole. Cleaning associated with the Level II underwater inspection was performed without damage to the pile. Soundings were performed on select piles at various locations to help assess the conditions of the piles. Soundings were performed by using a blunt object (i.e. hammer) to check for potential defects not visually apparent on the surface of the piles. Cleaning and testing methods described above were performed without damage to the piles.

3. DOCUMENTATION

The documentation resulting from the above-water and underwater inspection included field notes, photographs, underwater photographs and underwater video that were taken of the general conditions encountered. Select site inspection photographs are presented in **Appendix B** of this report and are also referenced within the text of the report.

Appendix C of the report provides a drawing describing the conditions encountered. The drawing was created by tracing and scaling the site features from an aerial image in CAD and supplementing with field measurements. Additionally, a typical section was created based on field measurements. Inspection field notes of the observed above-water and underwater structures and conditions are summarized in **Appendix D** of the report.

4. SITE CONDITIONS

The site is a City-owned facility that is composed of a timber pile-supported and timber-framed pier with an associated seasonal aluminum gangway providing access to a seasonal, bottom-anchored timber float. The float and gangway were not installed at the time of inspection. The pier was also used for access to several dingy outhauls tied up along both the north and south sides of the pier, as noted in the previous inspection report. The site is located within Magnolia Harbor to the southwest of Gloucester Harbor at 54 Shore Road, Gloucester, MA. The original pier was permitted in 1938 and is believed to have undergone several repairs to the above-water pier structure since that time. It is unknown as to the date of original construction and prior improvement work. A copy of the Chapter 91 License for the Magnolia Pier, License 1955, issued by the Department of Public Works in 1938, is presented in **Appendix F**.

The pier is approximately 6-foot wide by 270-foot long with a southwest jog located approximately 120 feet from the shoreline. The pier is supported by (52) fifty-two, 12-inch diameter, creosote-treated timber plumb piles spaced at approximately 10 feet on center with (16) sixteen, 12-inch diameter, creosote-treated timber batter piles located at every third bent along the pier starting at the fifth bent from shore (approximately 60 feet). Based on visual observation, it appears the top of the pier is approximately 9 to 10 feet above mean high water level.

The pier framing is composed of (2) two 3-inch by 12-inch timber split pile caps per bent, (3) three 6-inch by 6-inch timber stringers spaced at 2.5 to 3 feet on center, 3-inch by 12-inch timber cross-bracing and longitudinal bracing, and 2-inch by 8-inch timber decking. The pier railing is composed of 4-inch by 4-inch timber posts spaced at approximately 10 feet on center, 2-inch by 8-inch timber mid rail and 4-inch by 4-inch timber top rail. A reference site plan schematic (Figure 1) and typical pier sections (Figure 2) are presented in **Appendix C**.

B. EXISTING CONDITIONS

The observations below are based on above-water and underwater inspections of the Magnolia Pier performed on May 22, 2018. A reference plan of the structure is included in Figure 1 in **Appendix C** of this report.

1. TIMBER PILES

The overall observed condition of the timber pier piles ranged from **Satisfactory** to **Poor**, with limited areas of **Serious** to **Critical** condition observed on piles with deteriorated tops and pile bents that were observed to be wracked/leaning, presumably due to the recent storm event (See Photograph 15). This wracked/leaning condition was not observed in the inspection performed in 2015. A total of approximately eight (8) piles appeared to be wracked/leaning, and approximately three (3) piles had significant rot and/or significant section loss at the top of the pile (See Photograph 24). None of the piles were missing due to the storm event.

Minor to moderate deterioration, including delamination and marine borer damage along with rot, splitting and abrasion conditions, was observed on approximately 40 percent of the support (plumb) piles, and over 50 percent of the batter piles (See Photographs 6, 9, 19 to 24 and 27, 28). Moderate to severe corrosion was observed on the majority of hardware connections within the tidal zone (See Photographs 9, 18, 20, 25, 26).

One core sample was obtained from Pile B19B which penetrated the pile to 7 inches. The approximate 25 to 35 percent of the innermost portion of the pile appeared to have significant creosote treatment remaining whereas the outermost 65 to 75 percent of the pile varied in appearance and did not appear to have as much creosote content as the interior portion based on visual observations. See Table 1 in **Appendix D** for field notes/observed conditions of the timber piles.

2. PIER FRAMING (PILE CAPS, STRINGERS AND BRACING), DECKING AND RAILINGS

The overall observed condition of the timber pile caps ranged from **Good** to **Critical**, with approximately 30 percent of the pile caps observed to have minor to moderate checks and splits and approximately 10 percent of the pile caps were observed to be missing, broken, or severely deteriorated (See Photographs 8, 14, 15). The pile cap members in Bent 22 were missing.

The overall observed condition of the timber stringers ranged from **Good** to **Critical**, with approximately 20 percent of the stringers observed to have minor to moderate checks and splits and approximately 15 percent of the stringers were observed to be missing, broken, or severely deteriorated (See Photographs 6, 7, 12). The stringers between Bents 15 to 26 were observed to be newer pressure-treated timbers whereas the stringers between Bents 1 to 15 were observed to be older creosote-treated timbers with the top of the members deteriorated in several locations. In general, the newer pressure-treated stringers were in **Good** to **Fair** condition with minor to moderate checks and splits. The timber stringers spanning from Bents 21 to 23 were missing.

The overall observed condition of the bracing ranged from **Fair** to **Critical**, with approximately 30 percent of the bracing observed to be missing, broken/disconnected, or severely deteriorated. The majority of bracing members were observed to have minor to moderate checks/splits and trenching, along with minor to moderate damage due to marine borers within the tidal zone (See Photographs 10 to 12, 16 to 19, 22 to 26).

Approximately 30 percent of timber decking was observed to be missing with several other members deteriorated and partially and fully disconnected from the supporting stringers (See typical Photograph 10).

Approximately 40 percent of railing members were observed to be missing (See typical Photograph 10). See Table 2 in **Appendix D** for observed conditions of the pier framing, decking and railings.

Minor to severe corrosion was observed on the majority of hardware connections for the pile caps, stringers, and bracing members. Several of the pier framing fasteners were missing or severely corroded and not functioning to attach the associated timber member.

Although no floats, gangways or any other ancillary structures associated with the pier were included in the inspection scope of work, we did note that all but one of the existing ladders for access to dingy outhauls were missing along with the gangway connection and supporting framing members. Ladders and gangway connections were most likely detached during the March 2018 Nor'easters.

C. SUMMARY AND RECOMMENDATIONS

1. SUMMARY OF CONDITIONS

The condition of the Magnolia Pier was observed to be in overall **Poor** to **Critical** condition. The timber pier piles were observed to be in **Satisfactory** to **Poor** condition, with limited areas of **Serious** to **Critical** condition observed on piles that were observed to be wracked/leaning. In addition, several batter piles were observed to have significant rot and/or section loss at the top of the pile. The overall pier framing, decking and railing were observed to be in **Poor** to **Critical** condition, with areas of various missing members and advanced localized failures throughout. Various hardware connections were observed to have minor to severe corrosion, and various connections were observed to be missing and/or loose.

The pier sustained significant storm damage from the recent March 2018 storm events. The following summarizes the recent damage noted:

- Approximately 8 timber piles are wracked/leaning;
- Approximately 20% of the existing pile caps are damaged/missing;
- Approximately 25% of the existing timber stringers are damaged/missing;
- Approximately 40% of the existing timber bracing members are damaged/missing;
- Approximately 30% of the existing timber decking is missing. Additional members were observed to be partially or fully disconnected;
- Approximately 40% of the existing railings damaged/missing.

The pier is currently blocked off from access due to its damaged condition.

The conditions were based on visual observations during the time of inspection. It is unknown as to the subsurface conditions at the site or any information associated with installation of the piles, including embedment depths. GZA did not perform calculations to determine load capacity of the piles or other timber framing members.

The information contained within this report is based on the conditions observed at the time of inspection. The report is for general condition assessment purposes only and is not sufficient, in and of itself, to prepare construction documents for rehabilitation/replacement work. Existing conditions are subject to change.

2. RECOMMENDATIONS

The Magnolia Pier is an important structure for the residents and users in the Magnolia area of Gloucester. The Pier provides access to the water for recreational users including boaters who moor their boats within Magnolia Harbor.

The 2018 March Nor'easter storm event caused significant damage to the Cape Ann area with storm surge and high wave conditions occurring during astronomically high tides over several days. Based on review of on-line photographs taken during the storm event, it appears large waves were impacting the pier from a southerly direction with water/waves overtopping the structure.

It was reported during our prior inspection in 2015, the pier structure exhibits slight movement due to wave and wind acting onto the structure. Based on observations in comparing the March 2018 pre-storm conditions to the post-storm conditions, it is believed that the damage that occurred resulted in the pier not being able to withstand the significant loading due to the multi-day coastal storm event. The possible under design of the timber pier combined with the age and deterioration of timber members and fasteners most likely contributed to the damage observed.

Although a structural analysis and code compliant evaluation was not included in our project scope, it is our opinion that the original design elements of the pier do not meet today's code and design standards. Of concern, is the member sizing and span of the 6-inch by 6-inch timber stringers, the non-code compliant 4 inch by 4-inch post and timber railings, connections, and the overall ability of the pier to withstand environmental loading conditions due to severe coastal storm events. Due to the pre-existing, non-code compliant issues with the pier, the age and condition of the pier, the storm-damage conditions observed, the reported prior movement of the pier during waves/wind events, GZA does not recommend the pier be restored to its pre-storm condition.

GZA is aware of the importance of the pier to the local community. Based on the conditions observed, GZA has provided two alternatives for the City to consider for the repairs and replacement of the existing pier structure:

1) Alternate 1 – Improved Pier/Full Replacement (Timber)
2) Alternate 2 – Combined Repair/Replacement with Improvements

Realizing some of the pier's elements still have some potential useful life remaining, GZA has considered Alternate 2 – Combined Repair/Replacement with Improvements which would provide for replacement of the deteriorated, damaged or missing members and presumably non-code compliant members with other members remaining.

Each alternate contains a budgetary cost estimate for the proposed work. See **Appendix E** for breakdowns of the budgetary cost estimates. The two alternates for pier replacement and repairs is further detailed as follows:

a. Alternative 1 – Improved Pier/Full Replacement

Alternative 1 involves the full replacement of the structure, including all timber piles, framing members, decking, railings and fasteners. The pier replacement is anticipated to be located in the same basic footprint as the existing structure. Improvements to the width and height of the pier could be explored, however for the basis of this report, the pier replacement will be similar to the existing pier. Improvement to include; additional batter piles, additional bracing, increased sizing of the timber stringers, and code-compliant railings. This alternative, while costlier than Alternate 2 below, will provide the City with a safe, new pier with a longevity of approximately 30 to 50 years.

A budgetary cost estimate to replace the entire structure under Alternative 1 will range from **$740,000** to **$885,000**.

b. Alternative 2 – Replace Select Timber Piles and Framing Members

Alternative 2 involves replacing (30) select timber plumb piles, all (16) timber batter piles, installation of (20) new additional timber batter piles, new timber stingers, new railings and new select framing, decking and bracing members. In addition, all visibly corroded fasteners are included to be replaced, all decking members should be re-fastened, installation of a new gangway connection, and installation of new access ladders.

Based on the pier having a relatively narrow width versus the height, the unknown embedment depths of the piles, the deterioration at the connections and deterioration of the top of the batter piles, we feel that the batter piles and severely deteriorated connections and bracing should be replaced to improve lateral support of the pier. In addition, more frequent batter pile installations along the pier bents should be considered to provide increased lateral support.

At a minimum, we recommend that the 8 plumb piles observed to be wracked/leaning and/or observed to have major to severe deterioration be repaired or replaced immediately. We recommend that the 22 plumb piles observed to have moderate deterioration, splitting, abrasion, and/or marine borer action should be replaced. Piles to remain should be considered to be programmatically repaired or replaced within 5 years, or sooner if conditions worsen. The plumb piles observed to have minor deterioration, splitting, abrasion, and/or marine borer action should be considered to be repaired or replaced within 5 to 10 years, or sooner if conditions worsen. Additional options to be considered for piles with minor to moderate damage include, but are not limited to:

- Cut off the deteriorated top portion of the pile(s) and re-fasten with a new pile or post at a sound and durable portion of the existing pile.
- Fortify the deteriorated portion(s) of the pile(s) with protective wraps and/or coatings.

A portion of the pier structure including framing members, decking and railings were observed to be missing, broken, or severely deteriorated; we recommend that such elements be repaired or replaced. In addition, we recommend that elements with missing, loose, deteriorated, or corroded connections be repaired or replaced. The majority of the pier structure observed to have minor to moderate checks, splits, or marine borer action should be considered to be repaired within the next 5 to 10 years, or sooner if conditions worsen.

A budgetary cost estimate to replace select timber piles and select framing, bracing, decking and railing members under Alternative 2 will range from **$565,000** to **$680,000**.

The original Chapter 91 License for the Magnolia Pier, License No. 1955 issued by the Department of Public Works, is dated 1938, however the exact date the pier was originally constructed is unknown. The longevity of timber structures in marine environments is typically in the range of 30 to 50 years. Typically, more exposed portions of a timber structure, such as members exposed to the direct elements or in the intertidal zone, need replacement or repairs more frequently than the 30 to 50-year duration.

For Alternate 2, the frequency of future pile inspections would be dependent on the future repairs and replacement of the members. If no work is performed, inherent to the age of the piles, conditions observed and the marine environment exposure at the site, the piles should be inspected every two years and after major storm,

ice or flooding events. Future inspections should concentrate on level of advanced deterioration due to marine borer action, condition of fasteners, and possible impact/vessel-related damage and overall general conditions of the piles.

GZA recommends that the existing pier be replaced with a new improved pier structure (see Alternate 1 above). Alternate 1 considered a timber pier structure similar in footprint and size to the existing, however if a use change, or alternative construction material such as steel or concrete are desired, the budgetary cost estimate would be higher than for a timber structure.

In addition, pending the schedule for funding and permitting for new pier replacement, consideration should be given to removal of the pier, or partial removal of the upper decking, railing and framing members that have been damaged and are partially connected, in the near future. If future significant storm events occur, prior to reconstruction of the pier, the framing members could dislodge and impact adjacent public and private property and impact the adjacent environmental resource areas and could be a hazard to navigation.

Appendix A – Limitations

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of the City of Gloucester for the stated purpose(s) and location(s) identified in the Report.

2. The observations described in this Report were made under the conditions stated herein. The conclusions presented in the Report were based solely on the services described therein, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints.

3. This inspection report has been prepared for this project by GZA. This report is for the City of Gloucester's evaluation and management purposes only and is not sufficient, in and of itself, to prepare construction documents or an accurate bid.

LIMITS TO OBSERVATIONS

4. In reviewing this Report, it should be realized that the reported condition of the waterfront structures is based on observations of field conditions during the course of this study along with data made available to GZA GeoEnvironmental, Inc. (GZA). The observations of conditions reflect only the situation present at the specific moment in time the observations were made, under the specific conditions present. It may be necessary to re-evaluate the recommendations of this report when subsequent phases of evaluation or repair or nourishment and improvement provide more data.

5. Inspection was limited to accessible portions of the pier. Based on the Reference Site Plan in Appendix C, the landward limit of inspection started at Pile Bent 2.

Appendix B – Photographs

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
1	5/2018

Direction Photo Taken:

Description:
Google Earth Image of Magnolia Pier

Source:
Google Earth

Photo No.	**Date:**
2	5/22/18

Direction Photo Taken:
Southwest

Description:
View of Magnolia Pier along outer north side.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
3	5/22/18

Direction Photo Taken:
West

Description:
Topside view of Magnolia Pier from landside.

Photo No.	**Date:**
4	5/22/18

Direction Photo Taken:
Northeast

Description:
View of Magnolia Pier along outer south side.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
5	5/22/18

Direction Photo Taken:
West

Description:
View of Magnolia Pier along outer north side

Photo No.	**Date:**
6	5/22/18

Direction Photo Taken:
Southeast

Description:
Split and broken top of timber pile B2B and top of stringer at Bent 2.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
7	5/22/18

Direction Photo Taken:
West

Description:
Moderate to major deterioration and splitting of stringers between Bents 1 and 2

Photo No.	**Date:**
8	5/22/18

Direction Photo Taken:
East

Description:
Crushing of pile cap under center stringer at Bent 1.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
9	5/22/18

Direction Photo Taken:
East

Description:
Typical minor abrasion on timber piles at Bent 3 due to stone movement. Typical corrosion on hardware.

Photo No.	**Date:**
10	5/22/18

Direction Photo Taken:
South

Description:
Broken bracing, splitting on stringers, and missing decking between Bents 11 and 13.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
11	5/22/18

Direction Photo Taken:
Southeast

Description:
Missing cross and longitudinal bracing and missing railing and decking between Bents 17 and 18.

Photo No.	**Date:**
12	5/22/18

Direction Photo Taken:
South

Description:
Typical minor to moderate splitting on stringers. Missing bracing, decking and railing between Bents 18 and 19.

Photographic Log

Client Name: City of Gloucester	Site Location: 54 South Shore Road Gloucester, MA	Project No. 18.0173724.00

Photo No.	Date:
13	5/22/18

Direction Photo Taken:
Southeast

Description:
Bents 21 to 23 missing various pier members including pile caps, bracing, stringers, decking, and railings.

Photo No.	Date:
14	5/22/18

Direction Photo Taken:
Southeast

Description:
Split/broken pile cap, missing railing members, missing decking, and broken timber ladder at Bent 21.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
15	5/22/18

Direction Photo Taken:
West

Description:
Bents 24 and 25 observed to be leaning/wracked to the north.

Photo No.	**Date:**
16	5/22/18

Direction Photo Taken:
Southwest

Description:
Outer portion of pier with missing bracing, railing, and decking members

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No. 17	**Date:** 5/22/18
Direction Photo Taken: N/A	
Description: Typical deteriorated and broken cross bracing	

Photo No. 18	**Date:** 5/22/18
Direction Photo Taken: N/A	
Description: Broken bracing and loose and deteriorated fastener	

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
19	5/22/18

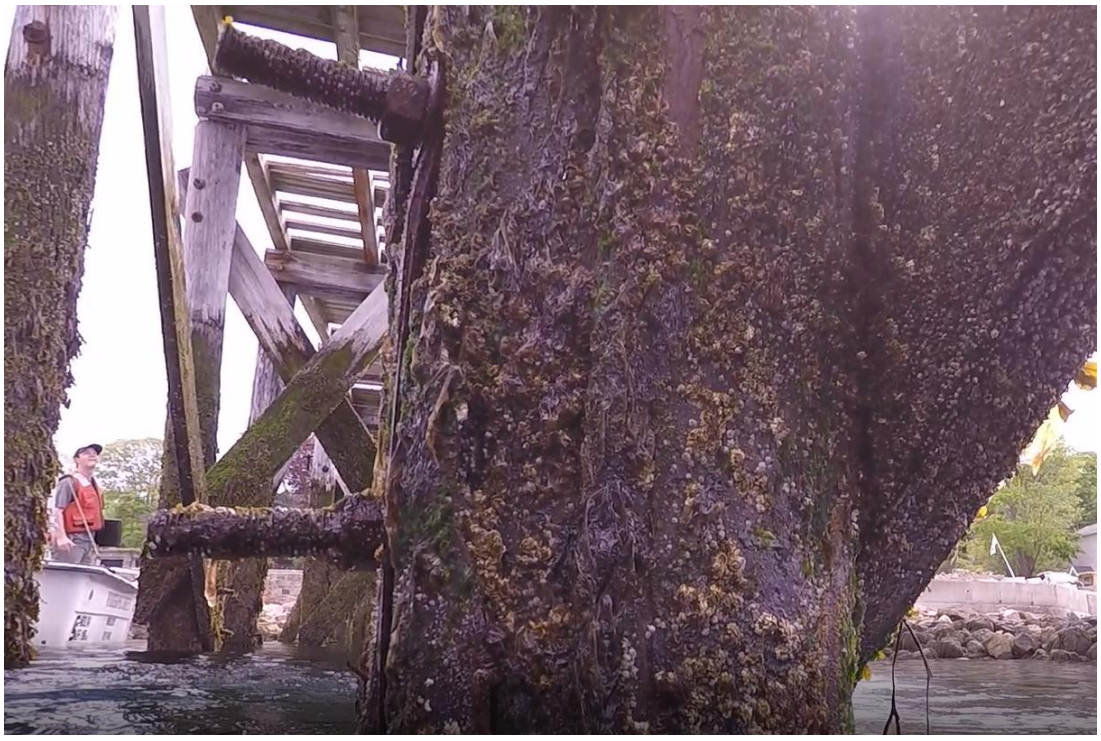
Direction Photo Taken:
East

Description:
Typical moderate to major deterioration and delamination on timber piles within the tidal zone. Disconnected bracing with minor checks and splits.

Photo No.	**Date:**
20	5/22/18

Direction Photo Taken:
East

Description:
Typical minor to moderate deterioration and splitting of timber pile B21C within tidal zone. Typical corrosion on hardware.



Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
21	5/22/18

Direction Photo Taken:
East

Description:
Typical moderate to major deterioration/ delamination and abrasion on timber pile B8D within the tidal zone.

Photo No.	**Date:**
22	5/22/18

Direction Photo Taken:
N/A

Description:
Typical pile with minor to moderate marine borer action with holes and delamination

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
23	5/22/18

Direction Photo Taken:
East

Description:
Typical deteriorated bracing and marine borer damage to piles with delamination Bent 26

Photo No.	**Date:**
24	5/22/18

Direction Photo Taken:
N/A

Description:
Moderate to major deterioration in top of batter pile B8A. Approximately 60% loss of section. Obtained from Inspection Report performed by GZA in 2015.

Photographic Log

Client Name: City of Gloucester	**Site Location:** 54 South Shore Road Gloucester, MA	**Project No.** 18.0173724.00

Photo No.	**Date:**
25	5/22/18

Direction Photo Taken:
N/A

Description:
Typical minor to moderate deterioration and splitting of lower cross bracing at Bent 26.

Photo No.	**Date:**
26	5/22/18

Direction Photo Taken:
N/A

Description:
Missing bracing and Severe corrosion on hardware at pile B20C.

Photographic Log

Client Name: City of Gloucester	Site Location: 54 South Shore Road Gloucester, MA	Project No. 18.0173724.00

Photo No. 27	Date: 5/22/18

Direction Photo Taken:
N/A

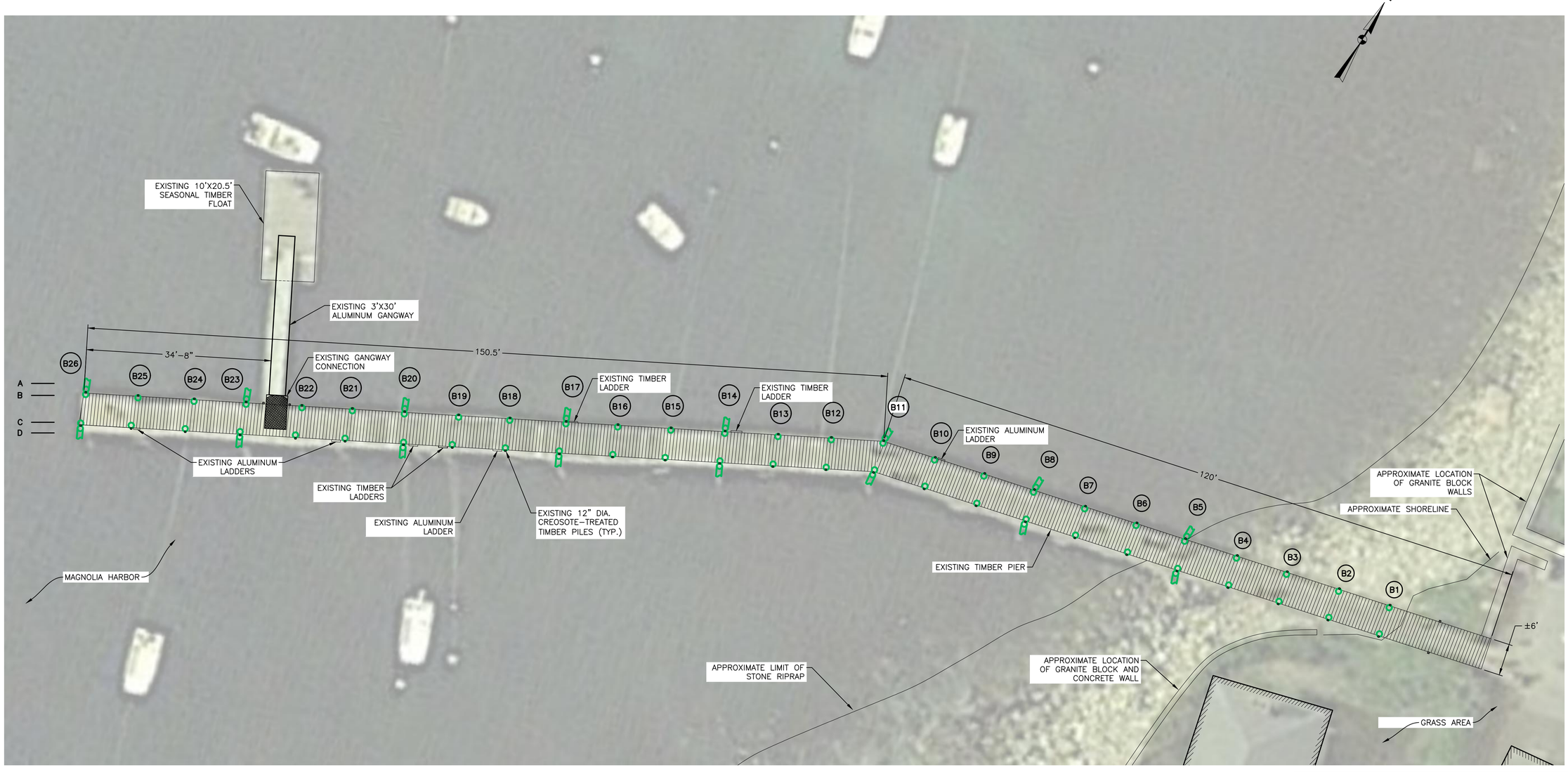
Description:
Typical minor to moderate marine borer damage on timber piles B25B.

Photo No. 28	Date: 8/21/15

Direction Photo Taken:
N/A

Description:
Typical minor to moderate delamination on timber pile B26D within tidal zone.

Appendix C – Figures
Figure 1. Reference Site Plan
Figure 2. Typical Pier Cross Section



REFERENCE SITE PLAN
SCALE: 1"=10'

LEGEND:

(B2)	BENT DESIGNATION NO.
O	EXISTING TIMBER PILE
A ——	PIER PILE ROW DESIGNATION

FOR REFERENCE ONLY

OBTAINED FROM PREVIOUS INSPECTION REPORT TITLED ABOVE AND UNDERWATER PILE INSPECTION REPORT, PREPARED BY GZA GEOENVIRONMENTAL, INC., DATED SEPTEMBER, 2015.

NOT FOR CONSTRUCTION

0 5 10 20
SCALE IN FEET

NOTES:

1. INSPECTION PERFORMED BY GZA GEOENVIRONMENTAL, INC. ON AUGUST 21, 2015 AND REPRESENTS CONDITIONS AT THE TIME OF THE INSPECTION.
2. PILE LOCATIONS ARE APPROXIMATE AND ARE FOR INSPECTION REFERENCE ONLY.
3. SITE PLAN CREATED BY TAKING FIELD MEASUREMENTS AND USING AN AERIAL IMAGE TO ORIENT LOCATION.
4. AERIAL IMAGE SHOWN FROM GOOGLE EARTH PROFESSIONAL, DATED JUNE, 2015.
5. BENT B1 IS LOCATED APPROXIMATELY 20' FROM THE LANDSIDE BLOCK WALLS, NO INTERMEDIATE PILE BENT WAS OBSERVED WITHIN THIS AREA.

NO.	ISSUE/DESCRIPTION	BY	DATE

MAGNOLIA PIER
54 SHORE ROAD
GLOUCESTER, MA

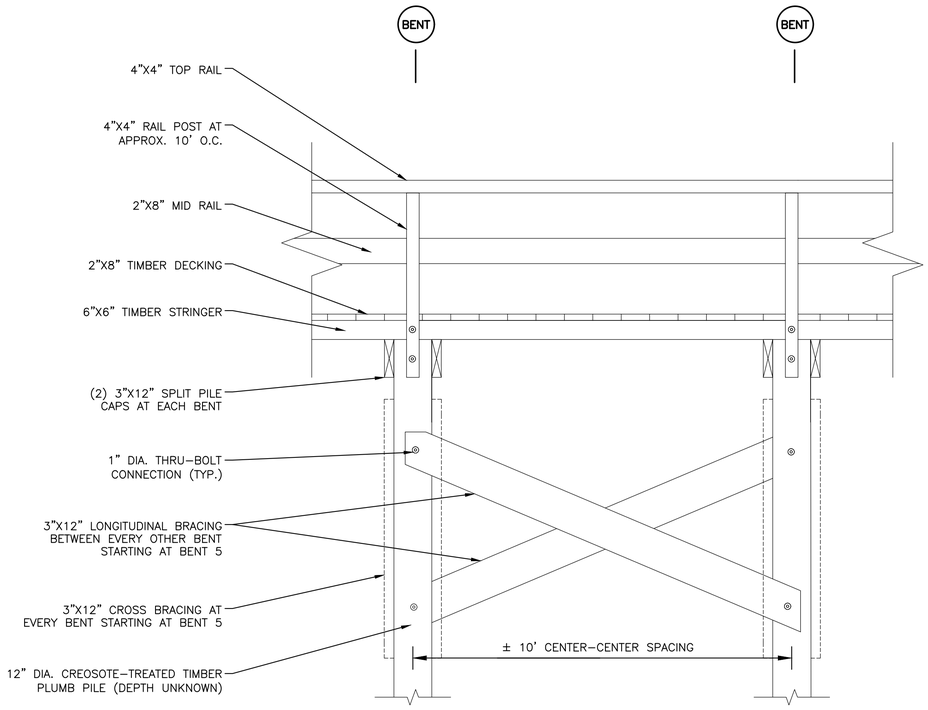
APPENDIX C
REFERENCE SITE PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

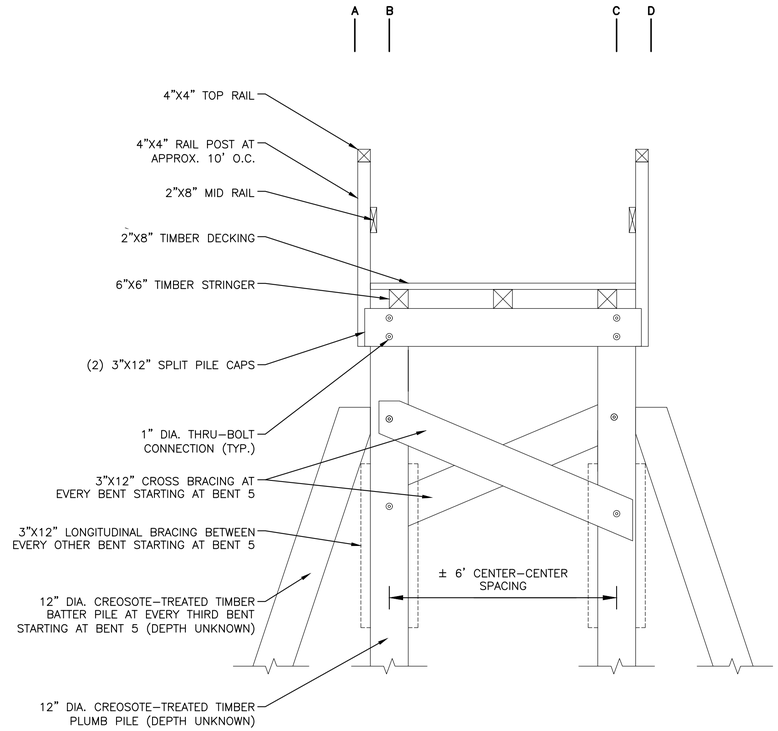
PREPARED FOR:
CITY OF GLOUCESTER HARBORMASTER AND WATERWAYS BOARD
19 HARBOR LOOP
GLOUCESTER, MA 01930

PROJ MGR:	DAS	REVIEWED BY:	ABB	CHECKED BY:	
DESIGNED BY:	DAS	DRAWN BY:	RKT	SCALE: AS NOTED	
DATE:	SEPTEMBER 2015	PROJECT NO.	18.0172459.00	REVISION NO.	

FIGURE 1
SHEET NO. 1 OF 2



TYPICAL LONGITUDINAL SECTION
SCALE: 1"=2'



TYPICAL CROSS SECTION FACING EAST
SCALE: 1"=2'

LEGEND:

(B2) BENT DESIGNATION NO.

A —— PIER PILE ROW DESIGNATION

0 1 2 4
SCALE IN FEET

NOTES:

1. INSPECTION PERFORMED BY GZA GEOENVIRONMENTAL, INC. ON MAY 22, 2018 AND REPRESENTS CONDITIONS AT THE TIME OF THE INSPECTION.
2. PIER SECTION VIEWS REPRESENT TYPICAL PIER ELEMENTS PRIOR TO STORM DAMAGE. ELEMENT SIZE AND LOCATION SHOULD BE CONSIDERED APPROXIMATE AND ARE FOR REFERENCE ONLY.
3. BATTER PILES NOT SHOWN FOR DRAWING CLARITY IN TYPICAL LONGITUDINAL SECTION.

NO.	ISSUE/DESCRIPTION	BY	DATE

MAGNOLIA PIER
54 SHORE ROAD
GLOUCESTER, MA

APPENDIX C
TYPICAL PIER SECTIONS

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
CITY OF GLOUCESTER HARBORMASTER AND WATERWAYS BOARD
19 HARBOR LOOP
GLOUCESTER, MA 01930

PROJ MGR:	DAS	REVIEWED BY:	ABB	CHECKED BY:	FIGURE 2
DESIGNED BY:	DAS	DRAWN BY:	LFT	SCALE: AS NOTED	
DATE: JUNE 2018		PROJECT NO. 18.0173724.00		REVISION NO.	SHEET NO. 2 OF 2

Appendix D – Magnolia Pier Condition Assessment Field Notes

Table 1 - Timber Piles	
Designation	**Observed Condition**
B1	Buried by stone/grade.
B2B	Broken at top of pile cap connection (appears to be missing railing post). Minor abrasion due to stone movement. Splitting at top of pile.
B2C	Minor abrasion due to stone movement. Splitting at top of pile.
B3B	Minor abrasion due to stone movement. Splitting at top of pile.
B3C	Minor abrasion due to stone movement. Splitting at top of pile.
B4B	Minor abrasion due to stone movement. Splitting at top of pile.
B4C	Minor abrasion due to stone movement. Splitting at top of pile.
B5A	Minor abrasion due to stone movement. Splitting at top of pile. Minor delamination 3 feet above stone.
B5B	Minor abrasion due to stone movement.
B5C	Minor abrasion due to stone movement.
B6B	Delamination at high water. Marine borer damage with hole 1-inch in diameter by 3-inch deep.
B7B	Trenching and marine borer action up to 6 feet above the stone. Minor abrasion due to stone movement.
B7C	Marine borer action at 1.5 feet above stone. Minor abrasion due to stone movement.
B8A	Hole through pile (missing bolt connection). Marine borer action at 2 feet above mudline. Delamination and splitting at 3 feet and 7 feet above mudline. Moderate to major rotting, approximately 60-70% section loss at top.
B8B	Checking/pitting at 4 feet to 5.5 feet above mudline. Marine borer action, 3-inch by 2-inch by 2-inch deep at 2 feet above mudline.
B8C	Marine borer action at 6 feet above mudline.
B8D	Delamination extending from mudline to 6 feet above mudline.
B9B	Hole through pile (missing bolt connection). Delamination at 2.5 feet and 5 feet above mudline.
B9C	Delamination at 2.5 feet and 5 feet above mudline.
B11A	Marine borer action at 1 foot above mudline. Deterioration/delamination 4-feet long within tidal zone.
B11D	Deterioration/delamination within tidal zone.
B12B	Splitting and trenching within tidal zone.
B13C	Trenching 6-inch long at 1 foot above mudline.
B14A	Trenching 18-inch long at 3 feet above mudline.
B14C	Hole through pile (missing bolt connection).
B14D	Trenching 3-inch wide and 4-feet long at mudline.
B15A	Appears to be racked/leaning. Minor marine borer action within tidal zone.
B15B	Hole through pile (missing bolt connection). Appears to be wracked/leaning. Minor marine borer action within tidal zone.
B16B	Trenching 1-foot long at 4 feet above mudline.
B16C	Marine borer action, hole 1-inch in diameter at 1 foot above mudline. Delamination within the tidal zone.
B17A	Marine borer action and trenching at 1.5 feet above mudline.
B18B	Moderate marine borer action and trenching, 6-feet to 7-feet long within tidal zone.

Table 1 - Timber Piles	
Designation	**Observed Condition**
B20A	Marine borer action at 1 foot and 4 feet above mudline. Moderate to major rotting, approximately 80-90% section loss at top.
B20B	Marine borer action and trenching, 3-inch by 3-inch at 3 feet above mudline. Hole through pile (missing bolt connection). Checking and delamination within tidal zone.
B20C	Hole through pile (missing bolt connection).
B20D	Marine borer action, (4) holes 1-inch in diameter within the tidal zone. Deterioration/delamination within the tidal zone.
B21B	Marine borer action 5 feet above mudline.
B21C	Deterioration/delamination, 5-feet long within the tidal zone.
B22B	Marine borer action at mudline. Appears to be wracked/leaning north.
B22C	Delamination and trenching within tidal zone. Appears to be wracked/leaning north.
B23B	Trenching 3-feet long at mudline. Gap at bolt connections.
B23C	Marine borer action within tidal zone. Trenching at 1 foot above mudline.
B23D	Marine borer action, delamination and trenching within tidal zone.
B24B	Marine borer action at 1 foot and 2 feet above mudline. Trenching within tidal zone. Appears to be wracked/leaning north.
B24C	Appears to be wracked/leaning north.
B25B	Marine borer action and deterioration/delamination within tidal zone. Appears to be wracked/leaning north.
B25C	Marine borer action at mudline. Appears to be wracked/leaning north. Moderate marine borer action and minor section loss within tidal zone.
B26A	Deterioration/delamination and trenching within tidal zone.
B26B	Delamination within tidal zone. Marine borer action at mudline.
B26C	Deterioration/delamination within tidal zone. Chunk of pile missing at bracing connection, approximately 5% section loss. Deteriorated marine borer hole 1-inch to 2-inch in diameter.
B26D	Delamination within tidal zone.

*All other piles visually observed to be in Satisfactory Condition.

Table 2 - Pier Framing, Decking and Railings	
Designation	**Observed Condition**
B1	Crushing of pile cap under center stringer. Splitting/checking of stringers.
B1 – B2	Missing (1) decking board. Missing north side railing post, mid rail and top rail.
B2	Deterioration/splitting of north stringer (disconnected from pile cap). Rot at end of south stringer (additional 2”x4” timber attached).
B2 – B3	Missing (3) decking boards. Missing north side railing post, mid rail and top rail; and south side mid rail.
B3	Splitting/checking of stringers.
B3 – B4	Missing (4) decking boards. Missing north side mid rail and south side mid rail and top rail.
B4	Splitting/checking of landward pile cap. Splitting at ends of seaward pile cap.
B4 – B5	Missing (3) decking boards. Missing south side mid rail and top rail.
B5 – B6	Splitting, trenching, and abrasion of tidal portions of longitudinal bracing. Missing (3) decking boards.
B6	Splitting/checking of cross bracing at lower connection.
B6 – B7	Missing (3) decking boards. Missing south side mid rail.
B7	Cross bracing not connected at pile.
B7 – B8	Deterioration and splitting of longitudinal bracing. Missing (3) decking boards.
B8	Splitting/checking and pitting of cross bracing.
B8 – B9	Missing (7) decking boards.
B9	Splitting/checking of cross bracing.
B9 – B10	Stringers appeared bowed. Splitting/checking of longitudinal bracing. Longitudinal bracing not connected at pile. Missing (7) decking boards.
B10	Missing seaward cross bracing. Splitting/checking of landward cross bracing.
B10 – B11	Missing (7) decking boards.
B11 – B12	Splitting/checking of north stringer (also appeared bowed). Broken longitudinal bracing. Missing (4) decking boards. Missing north and south mid rail.
B12	Missing and broken cross bracing.
B12 – B13	Missing (5) decking boards. Missing south side mid rail.
B13	Missing cross bracing.
B13 – B14	Missing longitudinal bracing. Marine borer action within tidal zone of longitudinal bracing. Missing (8) decking boards. Missing south side mid rail.
B14	Splitting on ends of pile caps.
B14 – B15	Splitting/checking of north stringer. Missing (2) decking boards. Missing north and south side railing posts, mid rails and top rails.
B15	Splitting and rotting of pile cap (appears shifted). Missing cross bracing.
B15 – B16	Missing longitudinal bracing. Missing (3) decking boards. Missing north side railing post, mid rail and top rail.
B16	Splitting on ends of pile caps. Missing cross bracing.
B16 – B17	Missing (4) decking boards. Missing north side railing post, mid rail and top rail; and south side mid rail.
B17 – B18	Missing (3) decking boards. Missing north side railing post, mid rail and top rail; and south side mid rail.
B18	Splitting/checking of pile caps. Missing cross bracing.

Table 2 - Pier Framing, Decking and Railings	
Designation	**Observed Condition**
B18 – B19	Splitting/checking of center stringer with orange discoloration. Missing longitudinal bracing. Missing (7) decking boards. Missing north side railing post, mid rail and top rail; and south side mid rail.
B19	Splitting/checking of cross bracing, and cross bracing not connected at pile.
B19 – B20	Missing longitudinal bracing. Missing (2) decking boards. Missing south side railing post, mid rail and top rail.
B20	Splitting/checking of pile caps. Missing cross bracing.
B20 – B21	Missing (4) decking boards. Missing north and south side railing posts, mid rails and top rails.
B21	Broken pile cap. Missing stringers. Cross bracing not connected at pile.
B21 – B22	Missing (15) decking boards. Missing north and south side railing posts, mid rails and top rails.
B22	Missing pile caps and stringers.
B22 – B23	Missing (15) decking boards. Missing north and south side railing posts, mid rails and top rails.
B23	Splitting/checking of pile cap and cross bracing. Missing stringers and cross bracing.
B23 – B24	Splitting/checking of longitudinal bracing. Missing (6) decking boards. Missing north side mid rail and south side railing post, mid rail and top rail.
B24	Deteriorated cross bracing.
B24 – B25	Missing (5) decking boards. Missing north side railing post, mid rail and top rail; and south side mid rail.
B25	Splitting/checking of pile caps and cross bracing.
B25 – B26	Missing north side railing post, mid rail and top rail; and south side mid rail.
B26	Splitting/checking of pile caps and cross bracing. Missing cross bracing.

*All other members visually observed to be in Satisfactory Condition.

Appendix E – Budgetary Cost Estimates

Magnolia Pier Condition Assessment

54 Shore Road, Gloucester, MA

Preliminary Engineer's Cost Estimate

June 2018

Alternate 1: Improved Pier/ Full Replacement						
	Items		QTY	Unit	Unit Price	Total
1	Mobilization and Demobilization		1	LS	$100,000	$100,000
2	Demolition/Disposal		1	LS	$75,000	$75,000
3	Remove and Reset Stone Revetment		1	LS	$25,000	$25,000
4	Timber Plumb Piles		52	EA	$3,500	$182,000
5	Timber Batter Piles		16	EA	$3,800	$60,800
6	Additional Timber Batter Piles		20	EA	$3,800	$76,000
7	Timber Pier Structure					
	a	Pile Caps	936	BF	$10	$9,360
	b	Stringers	3,240	BF	$10	$32,400
	c	Blocking	2,550	BF	$10	$25,500
	d	Bracing	2,700	BF	$10	$27,000
	e	Additional Bracing	1,350	BF	$10	$13,500
	f	Decking	3,240	BF	$12	$38,880
	g	Railings (including post, mid, top rail, infi	540	LF	$100	$54,000
8	Hardware Allowance		1	LS	$8,000	$8,000
9	Gangway to Pier Connection		1	LS	$3,500	$3,500
10	Ladders		8	EA	$800	$6,400
					Subtotal	$737,340
					Engineering, Design, Supervision and Administration 15%	**$110,601**
					Contingency 20%	$147,468
					Total Preliminary Construction Cost Estimate	**$884,808**

*Work includes:

1) Full replacement of the structure with improvements including all timber piles, framing members, decking and railings

Magnolia Pier Condition Assessment

54 Shore Road, Gloucester, MA

Preliminary Engineer's Cost Estimate

June 1, 2018

Alternate 2: Replace Select Timber Piles and Select Framing Members with Improvements						
	Items		QTY	Unit	Unit Price	Total
1	Mobilization and Demobilization		1	LS	$75,000	$75,000
2	Demolition/Disposal		1	LS	$60,000	$60,000
3	Timber Plumb Piles		30	EA	$3,500	$105,000
4	Timber Batter Piles		16	EA	$3,500	$56,000
5	Additional Timber Batter Piles		20	EA	$3,500	$70,000
6	Timber Pier Structure					
	a	Pile Caps	560	BF	$10	$5,600
	b	Stringers	3,240	BF	$10	$32,400
	c	Blocking	2,550	BF	$10	$25,500
	d	Bracing	2,700	BF	$10	$27,000
	e	Decking	972	BF	$12	$11,664
	f	Railings	540	LF	$75	$40,500
7	Hardware Allowance		1	LS	$6,500	$6,500
8	Gangway to Pier Connection		1	LS	$3,500	$3,500
9	Ladders		8	EA	$500	$4,000
					Subtotal	$522,664
					Engineering, Design, Supervision and Administration 15%	**$78,400**
					Contingency 20%	$104,533
					Total Preliminary Construction Cost Estimate	**$627,197**

*Work includes:

1) Replacement of select timber plumb piles:
    a) Eight piles wracked/leaning
    b) Four piles with major to severe deterioration
    c) Eighteen piles with minor to moderate deterioration, splitting, abrasion, etc.
2) Replacement of all timber batter piles (16)
3) Additional timber batter piles (20)
4) Replacement of select framing members, decking and railings
    a) Replacement of select (~ 60%) of pile caps
    b) Replacement of (100%) of stringers
    c) Replacement of select (~ 65%) of bracing members
    d) Replacement of select (~ 30%) of decking. Remove and replace existing
    e) Replacement of (100%) of railings

Appendix F – Historic Permit Document

Form WD 54.
500 sets-3-'35. No. 4006-a

The Commonwealth of Massachusetts

No. 1955.

Whereas, the City of Gloucester,----------

of----------, in the County of Essex---------- and Commonwealth aforesaid, has applied to the Department of Public Works for license to build and maintain a timber pier in Magnolia Harbor at the town landing in the city of Gloucester,----------

and has submitted plans of the same; and whereas due notice of said application, and of the time and place fixed for a hearing thereon, has been given, as required by law, to the----------Mayor and City Council---of the city---of Gloucester----------;

Now, said Department, having heard all parties desiring to be heard, and having fully considered said application, hereby, subject to the approval of the Governor and Council, authorizes and licenses the said

City of Gloucester----------, subject to the provisions of the ninety-first chapter of the General Laws, and of all laws which are or may be in force applicable thereto, to

build and maintain a timber pier in Magnolia Harbor at the town landing in the city of Gloucester, in conformity with the accompanying plan No. 1955.

Said timber pier may be built within lines described as follows: Beginning at a point marked A on said plan in the mean high water line and running northwesterly 100 feet, more

or less, to a point marked B; thence running westerly 190 feet, more or less, to a point marked C; thence running northerly 6 feet to a point marked D; thence running easterly 190 feet, more or less, to a point marked E; thence running southeasterly 100 feet, more or less, to a point marked F in the mean high water line; thence running southerly in the mean high water line to A, the point of beginning.

This license is granted subject to the laws of the United States.----------

The plan of said work, numbered ----------1 9 5 5,-------- is on file in the office of said Department, and duplicate of said plan accompanies this License, and is to be referred to as a part hereof.

~~The amount of tide water displaced by the work hereby authorized shall be ascertained by said~~ Department, and compensation therefor shall ~~be made by the said~~ heirs, successors

Form WD 54
500 sets-3-'35. No. 4006-b.

~~and assigns, by paying into the treasury of the Commonwealth~~

cents for each cubic ~~yard so displaced~~, being the amount hereby assessed ~~by said Department.~~

Nothing in this License shall be so construed as to impair the legal rights of any person.

This License shall be void unless the same and the accompanying plan are recorded within one year from the date hereof, in the Registry of Deeds for the----------Southern District of the County of Essex.

In Witness Whereof, said Department of Public Works have hereunto set their hands this ninth----------day of May,----------in the year nineteen hundred and thirty-eight.

Wm F Callahan
Richard K Hale
Frank L Kane

Department of Public Works

THE COMMONWEALTH OF MASSACHUSETTS

~~This license is approved in consideration of the payment into the treasury of the Commonwealth~~ by the said
of the further sum of

, the amount determined by the Governor and Council as a just and equitable charge for rights and privileges hereby granted in land of the Commonwealth.

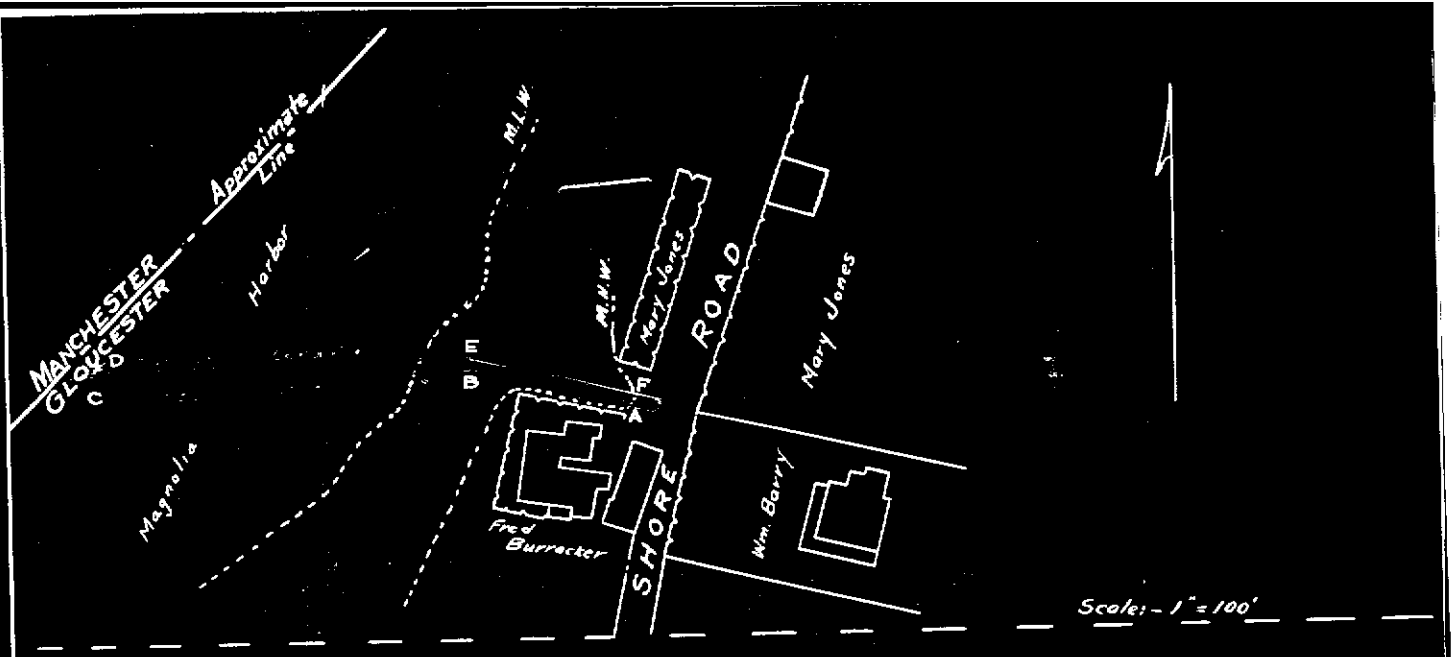
BOSTON, May 11, 1938

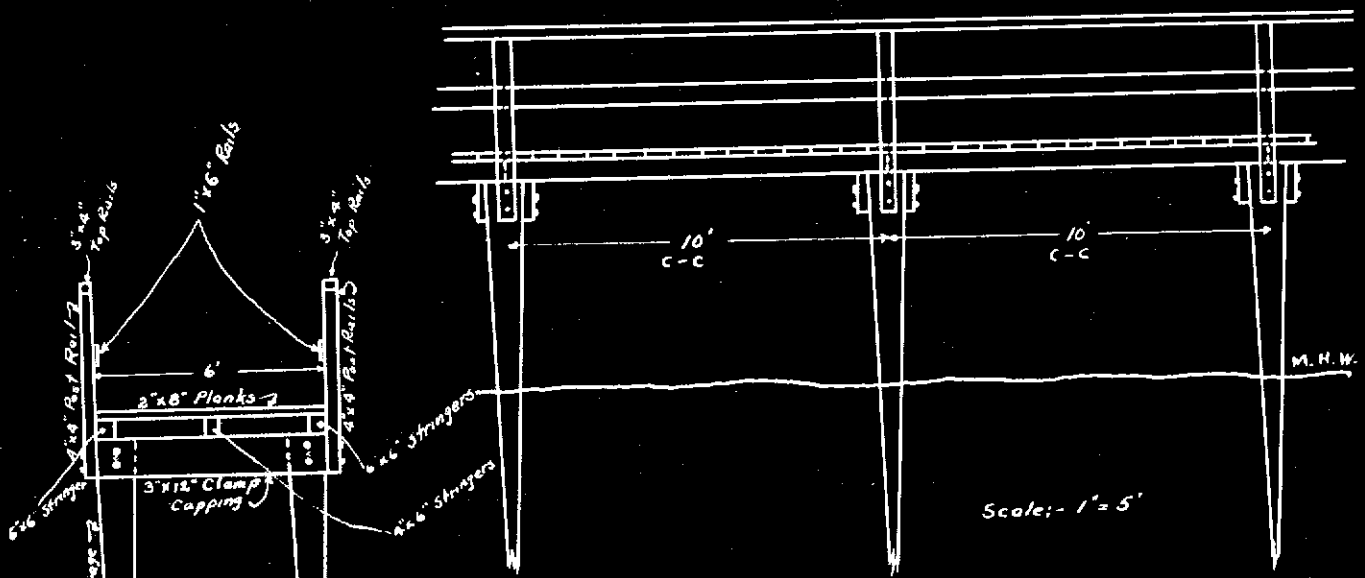
Approved by the Governor and Council.

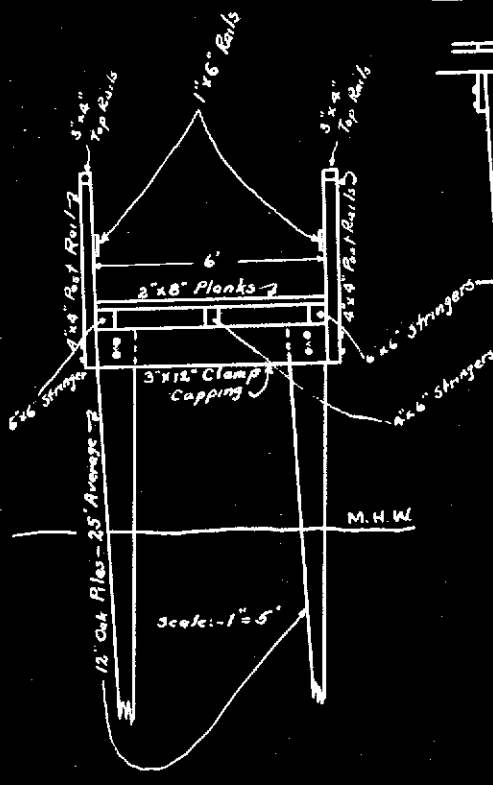
Wm L Reed
Executive Secretary.

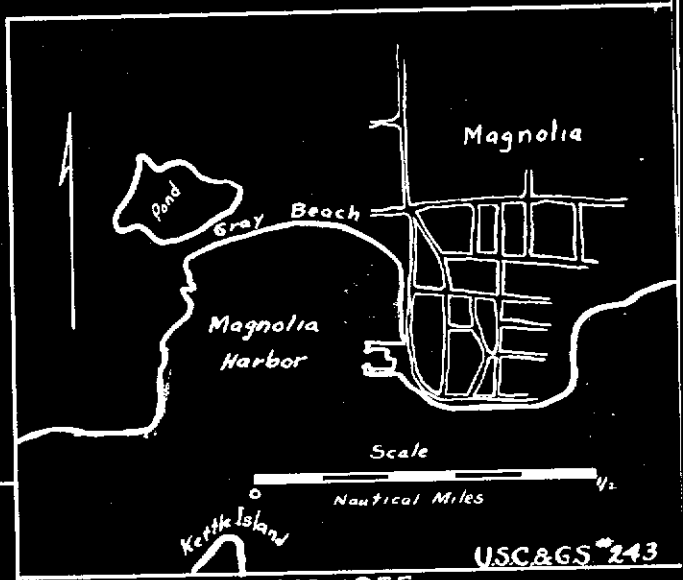
A true copy. Attest: Mary A. Riley *Secretary.*

No. 1 9 5 5.









PROPOSED TIMBER PIER
IN
MAGNOLIA HARBOR
GLOUCESTER MASS
APPLICATION BY THE
CITY OF GLOUCESTER
1938

NO. 1955
APPROVED BY DEPARTMENT OF PUBLIC WORKS
MAY 9, 1938

COMMISSIONER OF PUBLIC WORKS

ASSOCIATE COMMISSIONERS

GZA GeoEnvironmental, Inc.